Revell
Authentic Kits

THE INTERNAL COMBUSTION ENGINE

by Willem Weertman, *Managing Engineer, Engine Design Dept., Chrysler Corporation*

Illustrate with working model assembled from Revell Engine Kit.

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WHAT IS AN ENGINE?

An engine is a machine that converts one form of energy into another form which is more easily used. One of the most familiar engines in use today is the internal combustion engine. It converts energy stored in liquid fuels into heat, which is in turn changed into mechanical work or power. It is this power that is transmitted to the wheels of the family car.

HISTORY OF THE INTERNAL COMBUSTION ENGINE

Early workable gas engines, which ran on a mixture of natural gas and air, date back to about 1820, when an Englishman, W. Cecil, devised a simple type; but it remained for Samuel Brown, also in England, to put them into commercial use around 1823. A major advance came in 1838, when William Barnett discovered the importance of compressing the fuel-air mixture prior to combustion. With this discovery, and the increasing need for machinery to operate the equipment of a rapidly developing manufacturing economy, the internal combustion engine became more and more important.

The next really major improvement came with the arrival on the scene of Dr. N. A. Otto. In 1876, Dr. Otto developed a natural gas engine that made use of the four-stroke-cycle principle. These four stages in the running cycle had been well known for sometime, but Dr. Otto was the first man to put them to practical use in a working engine. Any engine which uses his principle is known as an Otto Cycle engine.

It should be noted that these engines were large units, designed for stationary use, and ran at a constant speed of about 175 revolutions per minute. Not until later were engines thought of in terms of locomotion.

In the summer of 1883, Gottlieb Daimler, a German, developed and ran the first high-speed internal combustion engine. It was a single cylinder, horizontal engine, with a hot tube ignition system. This was followed two years later by a lighter and more efficient vertical, water-cooled, single cylinder engine. It developed 1.1 horsepower at 650 rpm, and weighed 200 pounds. The same year Daimler put one of his engines in a wooden, motorcycle-like frame, and therefore receives credit for developing the first motorcycle.

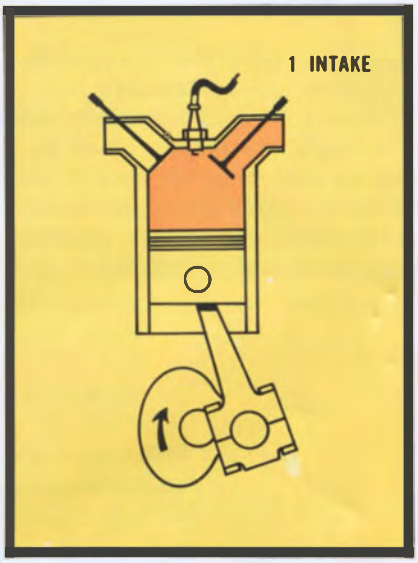
At the same time another German, Karl Benz, was at work on the same problem and developed a single cylinder, water-cooled, four cycle engine which he installed in a three-wheeled carriage. Benz gave the first public demonstration of this vehicle on July 3, 1886 by driving in and around Mannheim at a speed of about ten miles per hour. From this point on, progress was rapid.

Engines continued to improve, and it was not long before the automobile had firmly established itself as a practical means of transportation.

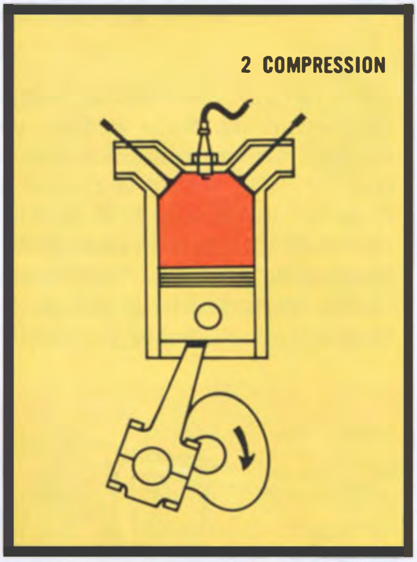
The single cylinder engine was soon replaced by two cylinders, and then in turn by four cylinders. Six, eight, twelve, and sixteen cylinders were not uncommon. A variety of designs appeared, and the internal combustion engine found its way into boats, airplanes, and lighter-than-air craft.

THE FOUR-CYCLE ENGINE

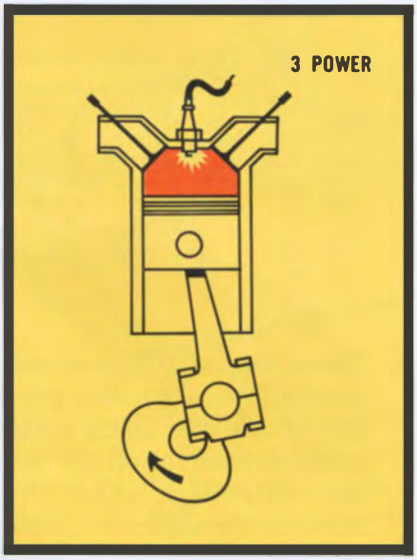
The most common type of internal combustion engine is known as a "four cycle," or "Otto Cycle" engine. As its name implies, there are four separate phases in its power-producing operation: 1. Intake; 2. Compression; 3. Power; 4. Exhaust.



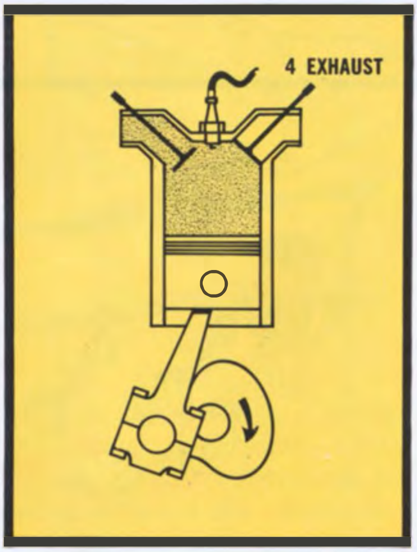
During the first or intake stroke, the piston is pulled down inside the cylinder by the connecting rod, which is attached to the crankshaft. As the piston moves down, the intake valve opens and a mixture of gasoline and air is sucked into the combustion chamber.



As the piston is pushed back up the cylinder on the second or compression stroke, with the intake valve now closed, the mixture is compressed in the narrow confines of the combustion chamber. This compression causes the temperature to rise rapidly, and just before the piston hits the peak of its upward travel, the spark plug fires and ignites the mixture.



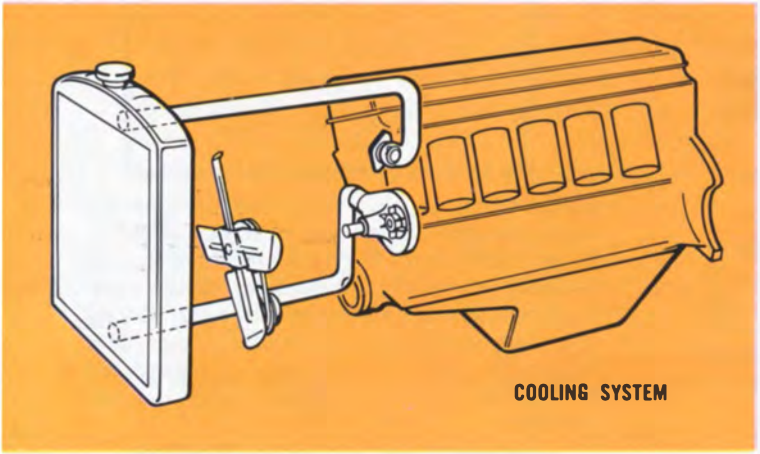
The high pressure, high temperature gas drives the piston back down the cylinder. This is the power stroke that causes the crankshaft to rotate and makes the engine a power producing machine.



As the piston starts back up the cylinder again, during the exhaust stroke, the exhaust valve opens, allowing the burned gases to escape from the combustion chamber. This makes room for a new charge of fuel during the next intake stroke.

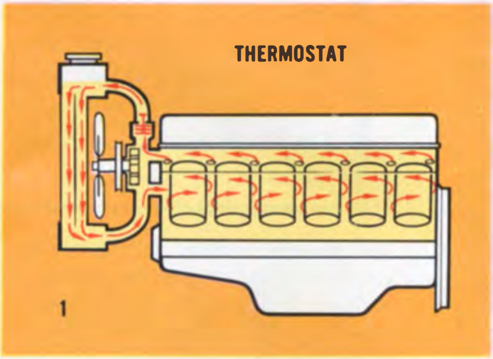
SUB-SYSTEMS OF THE INTERNAL COMBUSTION ENGINE

All internal combustion engines must have sub-systems in order to operate. Major among these is the *cooling system.* Some engines are air cooled, but a majority of automobiles depend on the passage of water around hot areas for cooling. The water is forced by the water pump through the engine block and cylinder head, where it picks up heat from the engine and then returns to the radiator where it is cooled. 1. With the thermostat open, water circulates freely throughout the entire system. 2. With the thermostat closed, the water remains in the engine until it is hot enough to open the thermostat and permit the water to enter the radiator for cooling.



COOLING SYSTEM

THERMOSTAT



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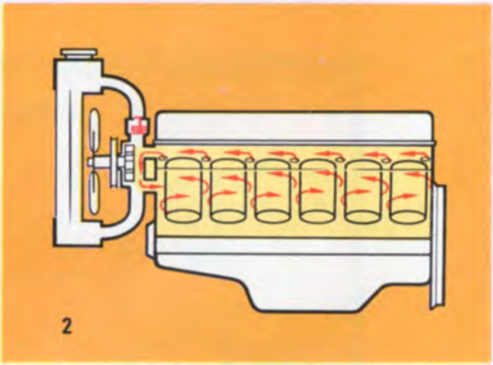

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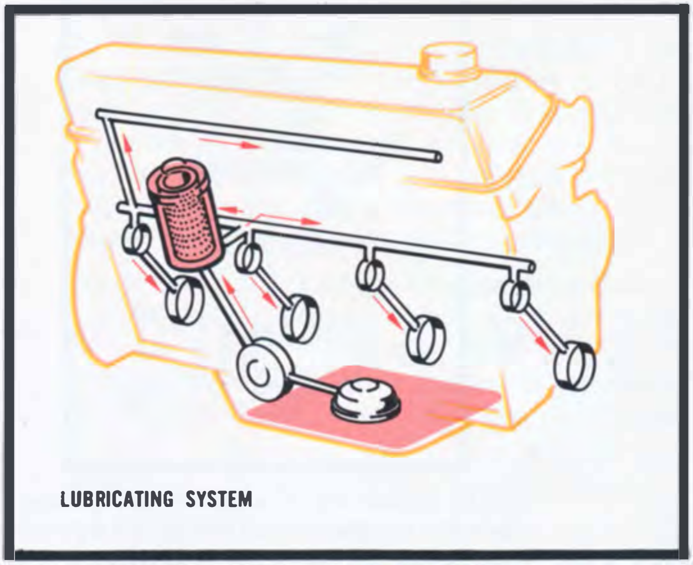
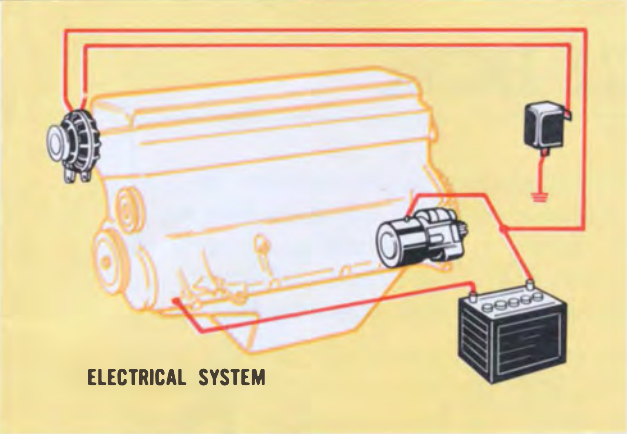
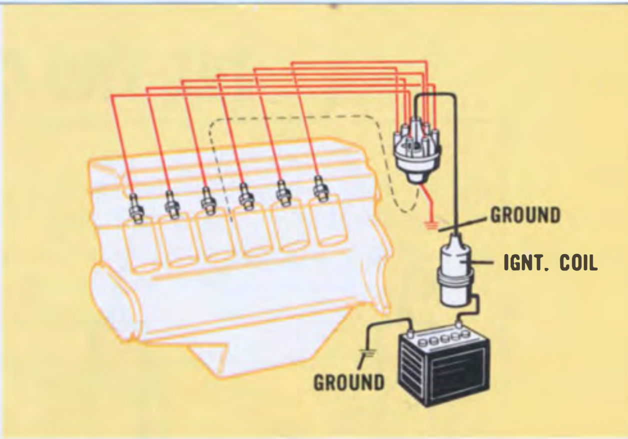


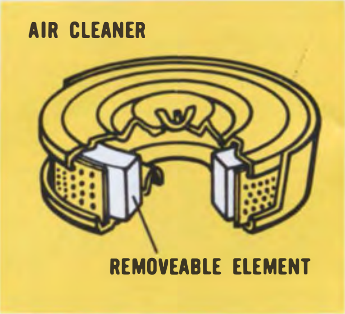
LUBRICATING SYSTEM

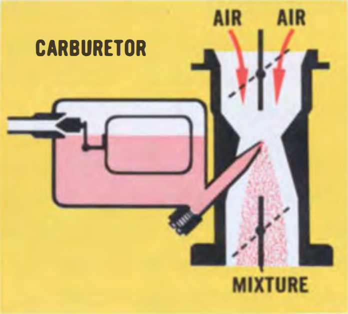
There must also be a *lubricating system.* Again, a pump, generally driven by a gear on the camshaft, sucks oil from the oil pan or sump and circulates it under pressure through the engine to areas that require pressurized lubrication. Lightly loaded areas are sometimes lubricated by splash lubrication rather than by oil under pressure.



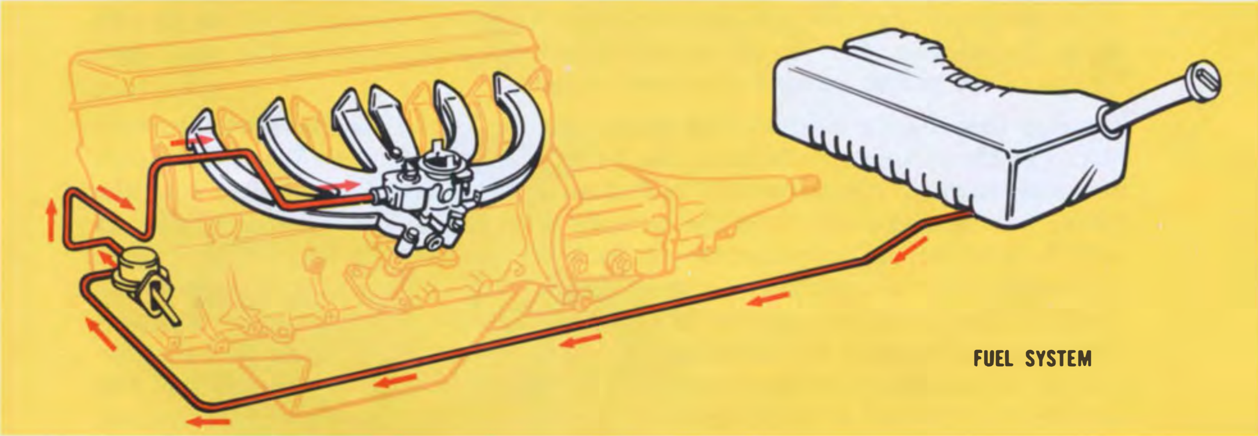


An *electrical system* is necessary to supply the accessory conveniences to the automobile, and consists of an alternator or generator, a regulator, a battery, and a starting motor. The ignition system which supplies the electricity needed to ignite the fuel-air mixture consists of the battery, coil, condenser, distributor, and spark plugs.

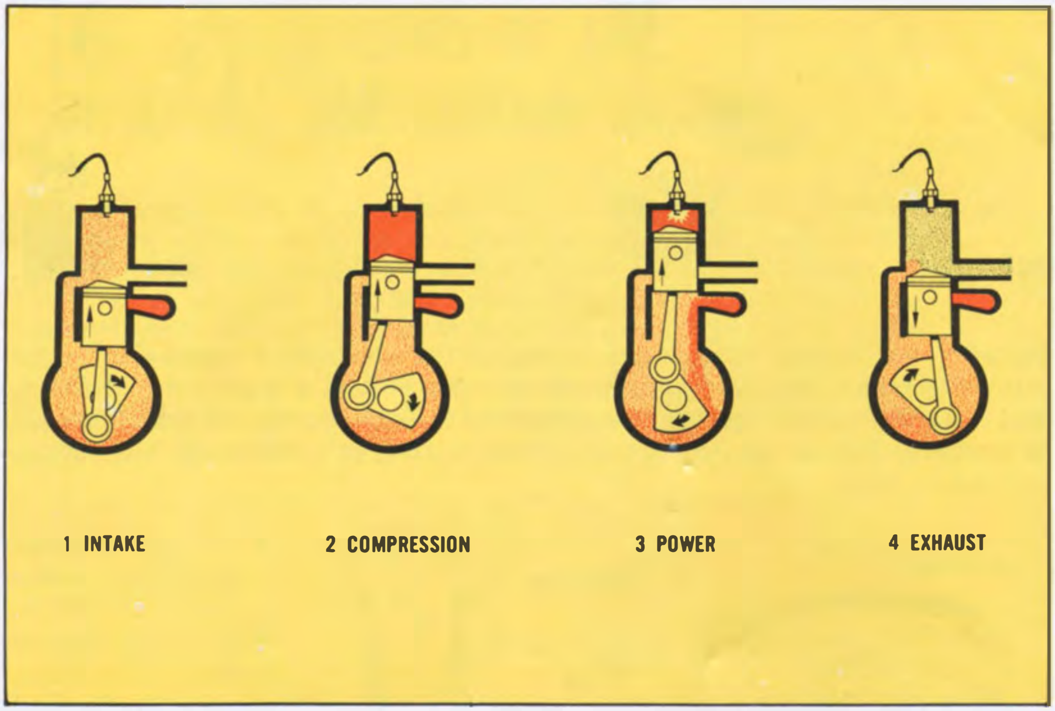




A *fuel system* is also a necessity for the engine's operation. The carburetor is probably the most complex component of this system. The function of this vital unit is to supply just the right mixture of gasoline and air to the combustion chamber. It achieves this through a combination of a constant level fuel bowl and controlled area fuel passages. Air is taken in through the carburetor, and the velocity of the air is increased by gradually reducing the intake diameter to the throat. Fuel is introduced into the carburetor at its narrowest point, the throat, where the fast-moving air picks up liquid fuel, atomizes it and carries it into the intake manifold. Here, the air and gasoline are thoroughly mixed, and as each intake valve opens, the fuel-air mixture enters the combustion chamber.



THE TWO-CYCLE ENGINE



There is another form of internal combustion engine in common use, which is found in motorcycles, lawn mowers, outboard motor boats, and model airplanes. It is called a two-cycle engine. While it is not as economical in terms of fuel consumed, it is tremendously effective in terms of power produced. This engine does not have mechanically operated valves, as does the four-cycle engine, but ports which are covered and uncovered by the piston during its travel up and down the cylinder. It is therefore able to get one power stroke for every two strokes of the piston, instead of one out of four.

The way this is accomplished is by having the intake and exhaust ports properly placed in the cylinder walls, near the bottom of the cylinders. When the piston moves downward, it compresses the fuel-air mixture in the crankcase until the intake port is uncovered, then the mixture flows through the cylinder wall port into the cylinder. As the piston travels back up into the cylinder, the intake port is covered, the exhaust port is covered, and then the mixture is *compressed*. Ignition takes place near the top of the stroke and the piston receives its *power*. The cycle continues as the piston moves downward compressing the fuel-air mixture in the crankcase. When the exhaust port is uncovered, the burned fuel and air starts to flow out of the cylinder. Shortly after the exhaust port is uncovered, the intake port is uncovered and the incoming fuel scavenges, or pushes, the burned fuel out the exhaust port. *Intake and Exhaust* portions of the cycle occur as the piston moves through the bottom of its stroke. Compression occurs as the piston moves up, and power is developed after ignition, as the piston moves down. The two-cycle engine delivers its maximum horsepower at high rpm, and is sometimes difficult to regulate and control in the low speed ranges. Many of these engines are designed to run without lubricating oil pumps. Instead, oil is added to the fuel and this oil lubricates the internal moving parts as it travels through the crankcase and cylinder along with the fuel.

THE SLANT- SIX ENGINES

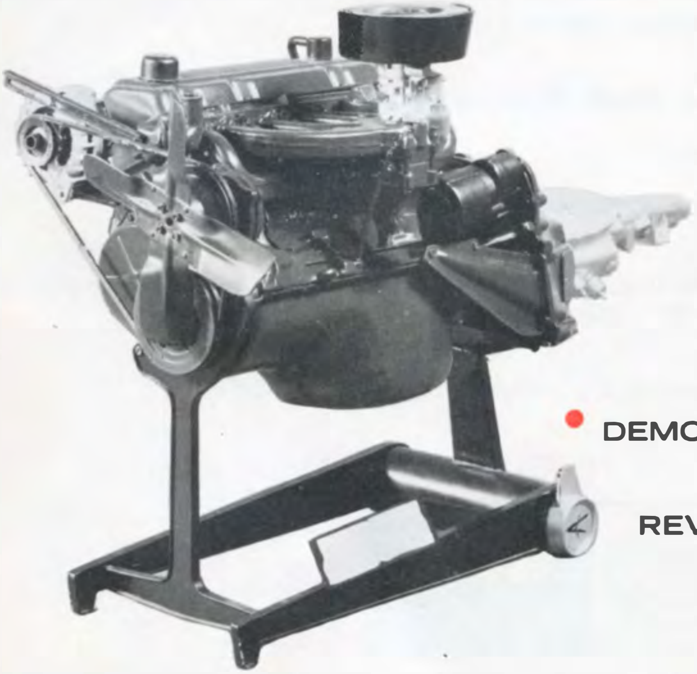
The engines that power modern American automobiles are the result of the years of development of the *four-stroke-cycle engine*. However, even these highly developed engines are in a period of transition. Several years ago it became apparent that smaller and more efficient engines were needed, and many of the manufacturers bent their efforts in that direction.

From the Chrysler Corporation came the Slant-Six Engine, with innovations that made it unique in engine design. It is an in-line six cylinder engine with overhead valves. This means that the valves are mounted in the head● and are operated by rocker arms,● and push rods.● The intake and exhaust manifolds are both on the left side of the engine. The intake manifold is of a new design,● in which long curved tubes supply just the correct amount of the fuel-air mixture to each intake port individually, thereby providing a better fuel-air mixture. Large radius exhaust manifolds● enable the burned gases to leave the combustion chamber quickly, thus eliminating power loss due to back pressure in the exhaust system.

The overall weight of the engine is reduced by using the most modern casting techniques, and by the extensive use of aluminum. The pistons, water pump housing, oil pump housing, water outlet elbow, distributor housing, clutch housing, and alternator housing are all made of cast aluminum.

In the Slant-Six, a new kind of electricity-generating device is employed. This unit is called an alternator. It develops alternating current, which it converts, by silicon diodes, to direct current. It weighs about 40% less than a normal generator, yet it will produce electricity even at the engine's idling speed.

Two sizes of Slant-Six engines are produced, a 170 cubic inch displacement engine and a 225 cubic inch displacement engine. The 170 cubic inch engine has a 3.40 bore and a 3.125 stroke delivering 101 horsepower at 4400 RPM. The 225 cubic inch has a 3.40 bore and a 4.125 stroke delivering 145 horsepower at 4000 RPM.



● DEMONSTRATE PRINCIPLES
WITH YOUR
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¼ Scale

THINGS TO KNOW

"THINKING IS FUN"
with
YOUR REVELL SLANT-SIX CHRYSLER CORPORATION ENGINE

1. What is Dr. Otto's contribution to the development of the internal combustion engine?

2. Who is credited with the development of the rudimentary motorcycle?

3. Name the four phases of an Otto cycle engine.

4. How does a two cycle engine differ from a four cycle engine?

5. Draw a diagram of a carburetor and explain how it works.

6. Describe the unique design features of the Slant Six engine.

7. When did Karl Benz first demonstrate his vehicle, and where?

8. What are the positions of the valves during the compression stroke?

9. How does the electrical system on the Slant-Six engine differ from that of other internal combustion engines?

10. Name the sub-systems usually found in an internal combustion engine.

11. What function does the carburetor perform?

12. How do you think building the Revell Slant Six engine kit added to your knowledge of automobiles and safe driving?

13. What are the positions of the valves during the exhaust cycle?

All answers in "THE INTERNAL COMBUSTION ENGINE"

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